STUDY PERFORMANCE REPORT

State: Michigan **Project No.**: F-35-R-24

Study No.: 678 **Title:** Development of location-specific reference conditions for stream biocriteria

Period Covered: April 1, 1998 to September 30, 1999

Study Objectives: 1) To develop location-specific, predictive models for biocriteria metrics (e.g., characteristics of fish or invertebrate communities) for Lower Peninsula streams. Models will link response variables to landscape variables using comparative analyses across a geographically-broad data set; similar to the approach used in earlier Study 631 (Seelbach and Wiley 1997; Zorn et al. 1997). 2) To demonstrate the development of predicted reference conditions for a selected set of river valley segment units, as delimited by Seelbach et al. 1997.

Summary: A 600-site rapid bio-assessment database was obtained from MDEQ, SWQD and georeferenced. A 400-site comprehensive fish survey database was obtained from MDNR, MRI. We chose to use SWQD's existing IBI metrics for warmwater streams and another regional set of metrics for coldwater streams, and calculated these metrics for all sites in both databases. Catchment boundaries were delineated for 200 SWQD sites, and landscape data clipped for each from digital maps using a GIS. These data were used in MRI predictive models to estimate stream temperature and hydrology variables for each site. Corresponding data for MRI sites were also obtained. Multiple linear regression models were developed for each of the 22 fish community assemblage metrics, for both SWQD and MRI databases. These models explained from 25.2% (% white suckers) to 78.6% (# total taxa) of observed variation in fish community assemblage characteristics.

Job 1. Title: Obtain and complete SWQD database.

Findings: Procedure 51 rapid bio-assessment data for fishes in Michigan streams were obtained from Michigan Department of Environmental Quality, Surface Water Quality Division (SWQD), discussed with MDEQ staff, and studied. Latitude and longitude coordinates were assigned to approximately 600 assessment site locations in the Lower Peninsula and these sites were mapped using ArcView software (ESRI).

Data on fishes from the Michigan Rivers Inventory (MRI) for both abundance estimates and presence estimates were also compiled, reviewed and utilized for parallel comparison to the Procedure 51 data.

Job 2. Title: Develop metrics for all surveyed sites.

Findings: IBI metrics developed by Karr et al. (1986) and other metrics used across the country as regional modifications or additions to the IBI were reviewed and compared to metrics employed in SWQD's Procedure 51. We chose instead to utilize the existing Procedure 51 metrics in model

development, as these were based on sound work in Illinois and Ohio, and are currently used in water quality assessment in Michigan. Since Procedure 51 metrics are only utilized to assess warmwater and coolwater streams, we also chose to develop the suite of coldwater metrics developed by Mundahl and Simon (1999) from Minnesota, Wisconsin, and Michigan fisheries data. We calculated warmwater and coldwater IBI metrics for both SWQD and MRI datasets. The metrics chosen for use in model development were:

Warmwater/Coolwater (MDEQ Procedure 51)

- # TotalTaxa
- # of Darter Species
- # of Sunfish Species
- # of Sucker Species
- # of Intolerant Species
- % Omnivores
- % Piscivores
- % Insectivores
- % Tolerant Individuals
- % Limnophilic Spawners

Coldwater Metrics (Mundahl & Simon 1999)

- # TotalTaxa
- # Coldwater Taxa
- # Coldwater Individuals/150 m
- % Coldwater Individuals
- % of Salmonids that are Brook Trout
- % Top Carnivores
- # Tolerant Taxa
- % Intolerant Individuals
- % White Suckers
- # Minnow Species
- # Benthic Species
- # Warmwater Individuals/150 m

Job 3. Title: Develop catchment descriptions for sites.

Findings: Two hundred sites containing fish assemblage data were randomly selected from the SWQD Procedure 51 database and the catchment areas for these sites were mapped from existing digital drainage area coverages developed by MDEQ hydrologists. Digital elevation, land use/land cover, soils, and surficial geology data layers were clipped using the catchment area polygons developed for the 200 sites. The compiled geologic and land cover data was then used to model additional variables for regression modeling including: mean, minimum, and maximum July temperatures, a number of hydrologic variables measuring both the magnitude and periodicity of flows, and groundwater contributions. Corresponding catchment and site data for MRI sites were also obtained.

Job 4. Title: Develop regression models that predict metrics from landscape variables.

Findings: Multiple linear regression models were developed for the 22 fish community assemblage metrics listed above. Multiple linear regression models were initially developed for the MRI fish

abundance database. The resulting, best-fit models developed for each metric were then applied to the fish presence MRI and Procedure 51 200-site subset databases. The fit and behavior of the models for the two latter databases were significantly different than for the abundance database. Separate multiple linear regression models were the developed for the Procedure 51 sub-sample. Regression models based upon site-specific landscape variables explained 25.2% (% white suckers) to 78.6% (# total taxa) of the variation in fish community assemblage characteristics.

It appeared possible to predict most tested measures of stream fish community assemblages based upon site-specific landscape variables. However, low R2 values of linear regression models for "% white suckers" and "# darter species" metrics raised questions about the utility of these metrics. The poor explanation of variation for the "# darter species" metric is believed due to MDEQ's use of both diverse darter and sculpin species (in many cases perhaps representing very different preferred thermal regimes) in the same metric. We wish to yet discuss this further with MDEQ staff, but this appears to be a misinterpretation of Karr's suggestions regarding use of this metric in other regions. Limiting the metric to certain darters alone may improve predictive models for it.

Job 7. Title: Write reports.

Findings: This annual progress report was prepared as scheduled.

Literature cited:

Karr, J.R., K.D. Fausch, P.L. Anermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey, Special Publication 5, Champaign.

Mundahl, N.D. and T.P. Simon. 1999. Development and application of an Index of Biotic Integrity for coldwater streams of the upper Midwestern United States. Pages 383-415 *In* Assessing the sustainability and biological integrity of water resources using fish communities. T.P. Simon, Editor. CRC Press, Boca Raton, FL.

Seelbach, P.W. and M.J. Wiley. 1997. Overview of the Michigan Rivers Inventory (MRI) Project. Michigan Department of Natural Resources, Fisheries Technical Report 97-3, Ann Arbor.

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Zorn, T.G., P.W. Seelbach, and M.J. Wiley. 1997. Patterns in the fish communities of Lower Michigan streams. Michigan Department of Natural Resources, Fisheries Research Report 2035, Ann Arbor.

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